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Optimizing random searches on three-dimensional lattices

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Search is a universal behavior related to many types of intelligent individuals. While most studies have focused on search in two or infinite-dimensional space, it is still missing how search can be optimized in three-dimensional space. Here we study random searches on three-dimensional (3d) square lattices with periodic boundary conditions, and explore the optimal search strategy with a power-law step length distribution, $p(l) \sim l^{-\mu}$, known as Lévy flights. We find that compared to random searches on two-dimensional (2d) lattices, the optimal exponent μ_{opt} on 3d lattices is relatively smaller in non-destructive case and remains similar in destructive case. We also find μ_{opt} decreases as the lattice length in z direction increases under high target density. Our findings may help us to understand the role of spatial dimension in search behaviors.

Keywords: random searches, spatial networks, search optimization, Lévy flights